Ref. Ares(2024)2327396 - 28/03/2024

D2.6.
Paper: Validation of cable configuration with experiments

[Version 1]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 860737.

Document History

Revision Nr	Description	Author	Review	Date
1	Final draft	Huzaifa Syed Academic supervision: Polimi Industrial supervision: OREC	Submitted/under review	27.03.2024
1.1	Final		Oana Trifan (TU Delft)	28.03.2024

Index

1. Overview

This report Optimizes the cost of dynamic cable configuration by exploring the Design variables within certain geometric constraints. Using Multidisciplinary design Analysis and optimization (MDAO) framework. This report has been published as a conference publication; in Journal of Physics for Conference TORQUE 2024 (estimated publication – May 31st 2024).This document provides an overview of the publication and its conclusions.

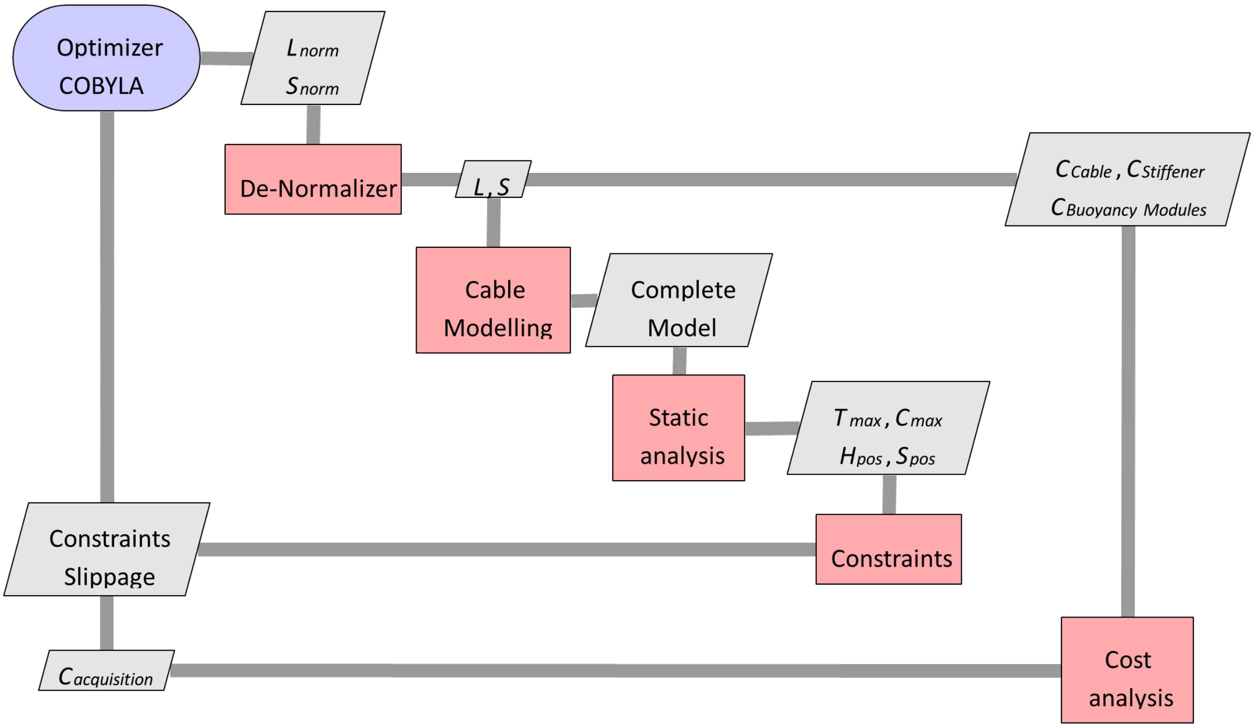
While the main title of the Deliverable is Validation of cable configuration with experiments, this could not be a paper title. Thus, the Paper title is named as follow: **Cost optimization of dynamic cable lazy wave configurations for floating offshore wind turbines.**

2. Abstract

This research aims to design a low-cost dynamic cable lazy wave configuration at different curvature factors by adopting an integrated approach to optimally size the length of different sections of the dynamic cable accounting for maximum allowable tension , maximum allowable curvature , minimum allowable sag position and maximum allowable hog position. The research explores trade-offs associated with the increase in costs as curvature factor decreases. The configuration is subjected to Near, Far and No offset scenarios to analyze the impact on costs and its performance. The assessment includes determining configuration costs and optimal lengths at different curvature factors for each scenario. Observations reveal that the hang-off point consistently experiences the highest curvature across the arc length in all configurations and scenarios. Optimal configurations for Far scenario outperform configurations designed for No offset scenario when subjected to the remaining two scenarios. Optimal configurations of Near scenario failed to adhere to the maximum allowable curvature limit when subjected to Far and No offset scenarios. The study highlights the sensitivity of the curvature factor to the ratio of lengths of each section in the configuration. These results indicate that a configuration designed for Far offset is more likely to perform well under all scenarios due to its unique section length ratios. The results also portray the possibility of a fit configuration with lower number of buoyancy modules.

3. Objectives

The objective of this paper is to Optimize cable configurations for acquisition cost by varying the design variables within the designated geometric and performance constraints of the configuration. This optimization deals with a 200m water depth site to optimize a lazy wave configuration. The following flowchart describes the steps taken to optimize the cable configuration. The geometric constraints include Hog position and sag position. The performance constraints include Curvature factor and Tension factor.



4. Conclusions

Parameter	No offset		Near offset		Far offset	
	CF	$C_{aquisition}$	CF	$C_{aquisition}$	CF	$C_{aquisition}$
l_1	0.18	0.29	0.18	0.33	0.17	0.26
l_2	0.16	0.17	0.22	0.16	0.15	0.16
l_3	0.66	0.54	0.60	0.52	0.68	0.58
$\frac{l_{total}}{h}$	2.72	2.51	2.55	2.34	2.88	2.23
TF	0.10	0.17	0.10	0.17	0.10	0.14

Table 1 Lazy wave optimization results

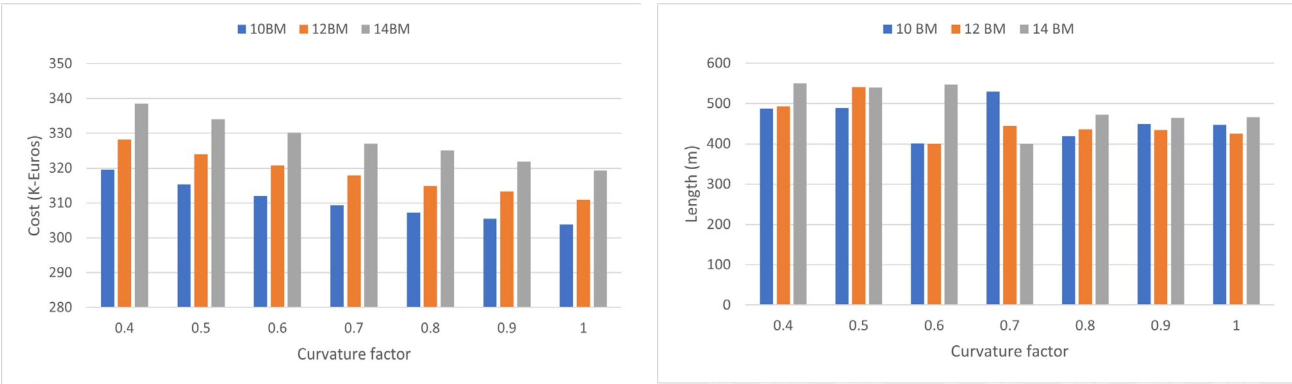


Figure 1 Optimized configurations for No Offset

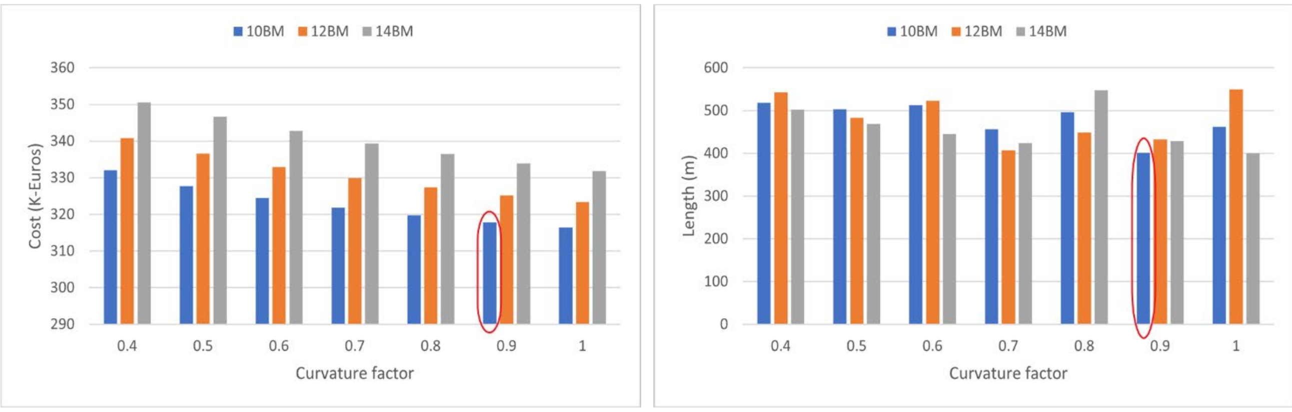


Figure 2 Optimized configurations for Far Offset

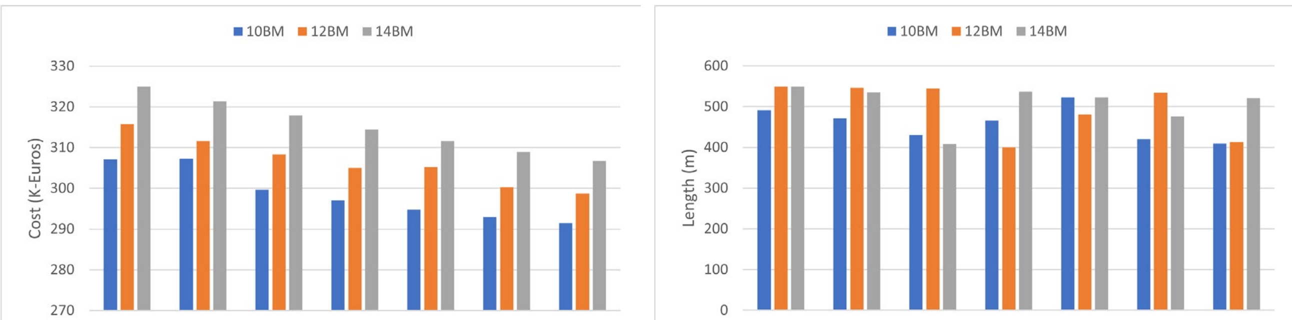


Figure 3 Optimized configurations for Near Offset

The optimization study of dynamic able lazy wave configurations performed provides valuable insights into achieving a balance between cost and performance. The clear correlation between cost and curvature factor underscores the complexity of designing dynamic cable systems. Configurations with lower curvature factors tended to incur higher costs, emphasizing the trade-off in meeting operational conditions. The survivability analysis across different scenarios revealed the robustness of configurations optimized for the Far and No offset scenarios. Notably configurations developed for Far configurations demonstrated consistent performance across all scenarios. Configurations optimized for the Near offset conditions failed to maintain curvature factors below the acceptable threshold in the remaining two scenarios. The best-performing low-cost configuration, with 10 buoyancy modules, showcased adaptability and efficiency in all scenarios, achieving average tension factors of 0.14 and an average curvature factor of 0.575. The findings highlight the importance of considering the impact of curvature factor and tension factors on the cost-effectiveness of cable configurations. This research informs the design process for dynamic cables, emphasizing the need for a comprehensive understanding of the trade-offs involved. The optimization methodology, integrating COBYLA algorithm and MDAO framework, proves effective ion navigating the design spaces and arriving at configurations that meet both operational and economic constraints. While this optimization is based only on static analysis, a natural extension involves subjecting the optimized configurations to dynamic simulations. Which could offer a more comprehensive understanding of how these configurations perform under real-world operational conditions, considering factors such as wave-induced motions, dynamic loading, and response to environmental variations. Expanding the study to encompass a broader range of environmental loads and diverse offshore sites would contribute to a more robust and versatile set of optimized configurations. Moreover, future optimization efforts could introduce additional design variables to the model. For instance, anchor positions and cable diameters could further refine the optimization process.